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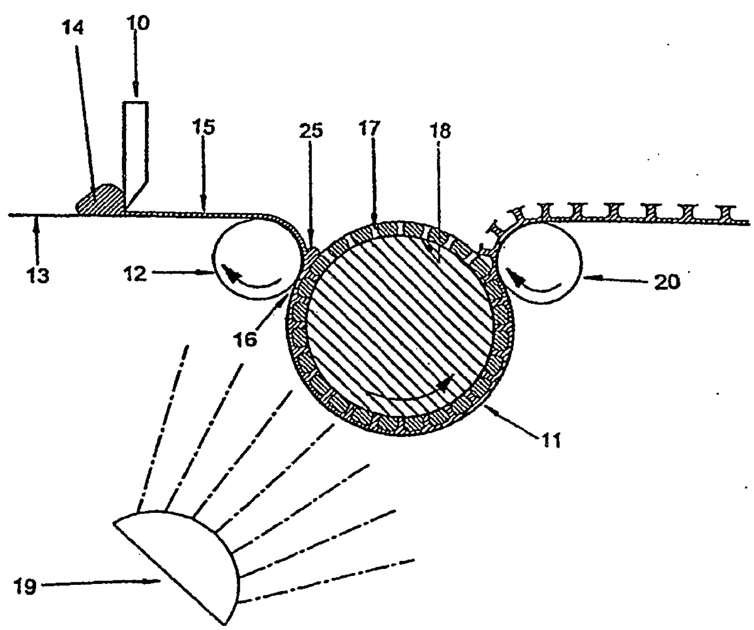
(54) Title: METHOD AND DEVICE FOR PRODUCING FASTENER PARTS FROM RADIATION CURED PLASTIC MATERIALS

(54) Bezeichnung: VERFAHREN UND VORRICHTUNG ZUR HERSTELLUNG VON HAFTVERSCHLUSSTEILEN AUS STRAHLENGEHÄRTETEN KUNSTSTOFFEN

(57) Abstract

The invention relates to a method for producing fastener parts comprising a plurality of hook elements (24). According to said method a formulation containing radiation cross-linkable prepolymers is shaped, cast and/or compression-moulded such that a plurality of hook elements (24) on a fastener base (21) is formed and then radiation cured. The invention also relates to a device for producing such fasteners, which comprises feed means (32, 10) for supplying the formulation (14) containing radiation cross-linkable, notably acrylated, prepolymers, at least one shaping roll (11) and a backing roll (12). The shaping roll (11) comprises a plurality of radial cavities (17). A source of ultraviolet (19) or electron radiation for radiation curing the shaped radiation cross-linkable formulation is also provided for.



(57) Zusammenfassung

Die Erfindung betrifft ein Verfahren zur Herstellung von Haftverschlussteilen mit einer Vielzahl von Verhakungsmitteln (24), wobei eine strahlenvernetzbare Prepolymere umfassende Formulierung in Form einer Vielzahl von Verhakungsmitteln (24) zusammen mit einem Haftverschluss-Grundkörper (21) geformt, gegossen und/oder gepresst und anschliessend strahlengehärtet wird. Die Erfindung betrifft auch eine Vorrichtung zur Herstellung von Haftverschlüssen, wobei die Vorrichtung Zuführmittel (32, 10) für die strahlenvernetzbare, insbesondere acrylierte Prepolymere umfassende Formulierung (14), wenigstens eine Formwalze (11) und eine Gegendruckwalze (12) umfasst und die Formwalze (11) eine Vielzahl von radial verlaufenden Ausnehmungen (17) aufweist und eine UV- (19) oder eine Elektronenstrahlungsquelle zur Strahlenhärtung der geformten strahlenhärtbaren Formulierung vorgesehen ist.

LEDIGLICH ZUR INFORMATION

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Verfahren und Vorrichtung zur Herstellung von Haftverschlußteilen aus strahlengehärteten Kunststoffen

Die vorliegende Erfindung betrifft ein Verfahren und eine Vorrichtung zur Herstellung von Haftverschlußteilen, die eine Vielzahl von Verhakungsmitteln aufweisen.

Bekannte Haftverschlußteile werden aus thermoplastischen Polyolefinen mittels Extrusion hergestellt. Hierbei wird der thermoplastische Kunststoff im plastischen oder flüssigen Zustand beispielsweise einem Spalt zwischen einer Druckwalze und einer Formwalze zugeführt, wobei die Formwalze eine Vielzahl von radial verlaufenden beidseitig offenen Ausnehmungen aufweist. Der thermoplastische Kunststoff dringt infolge des Linien-Quetschdrucks in die Ausnehmungen ein und härtet weitgehend aus, so daß die Haftverschlußteile als dreidimensionale Struktur von der Formwalze gelöst werden können. In dem Spalt zwischen der Form- und Druckwalze wird der Haftverschlußgrundkörper geformt, mit dem die Verhakungsmittel, nämlich die in den Ausnehmungen gebildeten Verhakungsschafte und die gebildeten Verhakungsköpfe, einstückig verbunden sind.

Vorzugsweise werden als Werkstoffe bei den herkömmlichen Verfahren thermoplastische Kunststoffe wie Polypropylen, Polyamid oder Polyethylen eingesetzt.

Ein solches Verfahren ist beispielsweise aus der WO 98/20767 bekannt.

Um eine ausreichende Versorgung der Ausnehmungen mit dem plastischen oder flüssigen Kunststoff zu erreichen, sind hohe Linien-Quetschdrücke von etwa 500 Kilogramm/m bis einigen Tonnen/m erforderlich.

Auch lassen sich - bedingt durch die relativ geringe Abkühlungsgeschwindigkeit der thermoplastischen Polymere - auf einer ca. 400 mm breiten Formwalze nur geringe Meterzahlen der dreidimensionalen Haftverschlußfolie herstellen.

Die Herstellung von Haftverschlußteilen durch Extrusion thermoplastischer Kunststoffe erfordert durch die Erwärmung der thermoplastischen Masse auf bis zu 300° C einen erheblichen Energieaufwand.

Da sowohl die maximale Breite der Flächenhaftverschlußbahn als auch die Mindestdicke der Flächenhaftverschlüsse bei den bekannten Verfahren herstellungsbedingt begrenzt sind, hat die Firma Velcro Industrie B.V. zur Herstellung von breiteren und sehr dünnen folienartigen Flächenhaftverschlüssen Längs- und/oder Querreckverfahren entwickelt, die in der PCT WO 98/32349 beschrieben sind. Neben dem hohen kostenintensiven Herstellungsaufwand ist bei diesem Verfahren nachteilig, daß aufgrund des jeweiligen Reckverfahrens die Anzahl der Verhakungsmittel pro Flächeneinheit deutlich reduziert ist.

Die Aufgabe der vorliegenden Erfindung besteht darin, ein neues Verfahren und eine neue Vorrichtung zur Herstellung von Haftverschlußteilen anzugeben, die bei vermindertem Energieaufwand eine Erhöhung der Herstellungsgeschwindigkeit ermöglichen. Weiterhin soll die vorliegende Erfindung die Bereitstellung von thermisch beständigeren Haftverschlußteilen ermöglichen sowie von Folienstrukturen mit äußerst geringer Dicke, wobei eine hohe Anzahl von hervorstehenden Elementen oder Verhakungsmitteln bereitgestellt wird.

Erstaunlicherweise wurde festgestellt, daß durch Verformen, Gießen und/oder Pressen einer strahlenvernetzbare, vorzugsweise acrylierte Prepolymere umfassenden Formulierung und anschließender Strahlenhärtung eine erhebliche Steige-

rung der Herstellungsgeschwindigkeit bei verminderten Energiekosten erreicht werden kann. Auch kann auf die Verwendung von Schutzgas bei geeigneter Auswahl der strahlenvernetzbaren Prepolymere verzichtet werden.

Bei der Strahlenhärtung von strahlenvernetzbare, insbesondere acrylierte Prepolymere umfassenden Formulierungen, die mittels UV- oder Elektronenbestrahlung erfolgt, werden außerordentlich hohe Polymerisationsgeschwindigkeiten erreicht. Im Vergleich zu den bekannten Herstellungsverfahren von Haftverschlußteilen aus thermoplastischen Kunststoffen kann durch das erfindungsgemäße Verfahren die Walzenumdrehungsgeschwindigkeit und damit die pro Zeiteinheit hergestellte Länge der dreidimensionalen Bahnen verzehnfacht werden.

Da die Polymerisation mittels Strahlenvernetzung keine Erwärmung der härtbaren Masse wie bei den bekannten Verfahren erfordert, ist das erfindungsgemäße Verfahren auch energiesparend.

Die Strahlenhärtung bietet weiterhin den Vorteil, daß die Polymerisation ohne Freisetzung von Spaltprodukten erfolgt. Die strahlenvernetzbaren, insbesondere acrylierten Prepolymere werden vielmehr nahezu quantitativ untereinander und gegebenenfalls auch mit vorhandenen Reaktivlösungsmitteln vernetzt.

Durch die Verwendung strahlenvernetzbarer, insbesondere acrylierter Prepolymere können thermisch beständige Haftverschlußteile hergestellt werden, die beispielsweise auch als Haftverschlußteile für Schleifscheiben oder sonstige Arbeitsgeräte einsetzbar sind. Eine besonders hohe thermische Beständigkeit weisen die stark vernetzten acrylierten Polymere auf, die durch Strahlenhärtung von Formulierungen hergestellt werden, die Vernetzungsstellen fördernde bi- und/oder trifunktionelle Prepolymere und/oder Monomere umfassen. Diese Polymere, die im Gegensatz zu den bekannten Polyolefinen, Polyamiden und Polyestern auch bei Temperaturen von größer 300° C eingesetzt werden können, sind im wesentlichen Duroplaste.

Durch die geeignete Auswahl der jeweiligen strahlenvernetzbaren Prepolymere und gegebenenfalls auch Monomere können auch Polymere mit eher thermopla-

stischen Eigenschaften hergestellt werden, indem der Anteil an monofunktionellen Prepolymeren und gegebenenfalls Monomeren erhöht wird.

Die Eigenschaften der Polymere hängen selbstverständlich auch von der Kettenlänge und dem Vernetzungsgrad der eingesetzten Prepolymere ab.

Als strahlenvernetzbare, insbesondere acrylierte Prepolymere können beispielsweise Polyesteracrylate, Epoxyacrylate, Polyetheracrylate, Silikonacrylate oder Urethanacrylate eingesetzt werden.

Bevorzugt ist die Verwendung von Urethanacrylaten, da diese ohne Schutzgas strahlenvernetzbar sind. Bevorzugte Urethanacrylate sind die aliphatischen mono-, bi- oder trifunktionellen Urethanacrylate, wobei die aliphatischen Gruppen zur Flexibilität des Kunststoffes beitragen. Bevorzugt werden bifunktionelle aliphatische Urethanacrylate eingesetzt. Prinzipiell ist es ebenfalls möglich, wenigstens teilweise aromatische Urethanacrylate verschiedener Funktionalität einzusetzen. Bevorzugt sollte die Viskosität der eingesetzten Prepolymere zwischen 3.000 und 60.000 mPa s betragen.

Darüber hinaus können auch andere strahlenvernetzbare Prepolymere in der Formulierung verwendet werden. Unter Schutz- und/oder Inertgas können auch folgende Prepolymere eingesetzt werden:

1. Polyesterharze oder chlorierte Polyesterharze, oder
2. unter Ausnutzung eines kationischen Vernetzungsmechanismus
a) cycloaliphatische Epoxidharze oder
b) Epoxi-polyol-blends.

Bei der Verwendung von strahlenvernetzbaren, insbesondere acrylierten Prepolymeren ist es infolge der relativ hohen Viskosität meist erforderlich, die Formulierung durch Zusatz von Reaktivverdünnern, insbesondere Monomeren, auf die geeignete Viskosität zu verdünnen. Durch die geeignete Wahl der zugesetzten Monomere kann die Härte, der Vernetzungsgrad und die Flexibilität des polymeren Endproduktes sowie die Viskosität der Ausgangsformulierung eingestellt werden.

Bei der Polymerisation werden die Monomere in das Netzwerk eingebaut, so daß das Polymer nahezu keine Lösungsmittel freisetzt.

Vorzugsweise werden bei der Verwendung acrylierter Prepolymere als monomere Reaktivverdünner Acrylate eingesetzt, die über eine vielfältige Funktionalität verfügen.

Durch den Zusatz monofunktioneller Acrylate werden Verringerung der Härte, Erhöhung der Flexibilität und gute Adhäsionseigenschaften des Polymers erreicht. Auch bewirken monofunktionelle Monomere eine geringere Schrumpfung bei der Polymerisation. Prinzipiell können alle bekannten monofunktionellen Acrylate eingesetzt werden. Vorzugsweise werden die monofunktionellen Acrylate aus der aus Butylacrylat, 2-Ethylhexylacrylat, Hydroxyethylacrylat, Hydroxypropylacrylat, 4-Hydroxybutylacrylat, Ethyldiglykolacrylat, Isodecylacrylat und 2-Ethoxyethylacrylat bestehenden Gruppe ausgewählt, wobei Ethoxyethylacrylat und Isodecylacrylat besonders bevorzugt sind.

Auch der Zusatz von bi- oder trifunktionellen Acrylaten bewirkt die Einstellung der gewünschten Eigenschaften wie Härte und Flexibilität. Als bifunktionelle Monomere werden vorzugsweise Diethylenglykoldiacrylat, Dipropylenglykoldiacrylat, Triethylenglykoldiacrylat, Tripropylenglykoldiacrylat oder 1,6-Hexandioldiacrylat verwendet, wobei 1,6-Hexandioldiacrylat besonders bevorzugt ist.

Falls gewünscht, können auch trifunktionelle Acrylate wie Trimethylolpropantriacrylat oder Pentaerythrittriacrylat oder auch höherfunktionelle Acrylate eingesetzt werden.

Es ist ebenfalls möglich, propoxilierte Monomere einzusetzen, die sich durch eine geringere Hautreizwirkung auszeichnen.

Vorzugsweise wird ein Monomerengemisch aus mono- und bifunktionellen Acrylaten eingesetzt, insbesondere ein Gemisch aus 2-Ethoxyethylacrylat und 1,6 Hexandioldiacrylat. Die jeweiligen Konzentrationen der zugesetzten Monomere zu der Formulierung hängen von der erforderlichen Viskosität der Formulierung und der gewünschten Härte, Flexibilität, den Adhäsionseigenschaften des Polymers, der Reaktionsgeschwindigkeit etc. ab.

Ein Gemisch aus mono- und bifunktionellen Acrylaten, insbesondere Ethoxyethylacrylat oder Isodecylacrylat mit Trimethylolpropantriacrylat, hat sich ebenfalls bewährt.

Ein weiterer Vorteil der Herstellung der Haftverschlußteile aus strahlenvernetzbaren Prepolymeren und Monomeren besteht darin, daß sich durch die Wahl der eingesetzten Monomere die Adhäsionseigenschaften des Kunststoffs steuern lassen und daß ohne die bei den bekannten Thermoplasten erforderlichen zusätzlichen Oberflächenbehandlungsschritte durch Corona-Entladung, Gasflammbehandlung oder Fluorierung eine hinreichende Haftung des Kunststoffs auf einem gewünschten Träger erzielt werden kann. Somit kann bei dem erfindungsgemäßen Verfahren ein Arbeitsschritt eingespart werden.

Um eine hinreichende Polymerisation zu erreichen, ist es erforderlich, bei Einsatz von UV-härtbaren Formulierungen einen Photoinitiator zuzusetzen, der bei Anregung durch UV-Strahlung die die Kettenreaktion startenden Primärradikale bildet.

Als Photoinitiatoren können prinzipiell sämtliche bekannten, bei UV-Absorption Radikale freisetzenden Moleküle eingesetzt werden, wie beispielsweise α–Hydroxyketon, α–Aminoketone, Benzildimethylketale, Bis-benzoylphenylphoshinoxide, Metallocene und deren Derivate.

Besonders bevorzugt ist, einen 2-Hydroxy-2-methyl-1-phenyl-propan-1-on enthaltenden Photoinitiator, beispielsweise Darocur 1173 der Firma Ciba Geigy, zu verwenden.

Der Formulierung können selbstverständlich weitere übliche Zusätze wie zum Beispiel Farbstoffe, Stabilisatoren, Sauerstoff-Fänger, Ferritpulver zugesetzt werden.

Die Viskosität der strahlenvernetzbaren Formulierung ist von den speziellen Herstellungsbedingungen, zum Beispiel dem Linien-Quetschdruck zwischen den Formwalzen, abhängig. Vorzugsweise sollte die Viskosität der Formulierung zwischen 150 und 20.000 mPa s betragen, besonders bevorzugt sind Viskositäten zwischen 300 und 5.000 mPa s.

Der Prozentsatz der der strahlenhärtbaren Formulierung zugesetzten Prepolymere hängt von der erforderlichen Viskosität der Formulierung, den Eigenschaften der Prepolymere und Monomere und den gewünschten Eigenschaften des herzustellenden Kunststoffmaterials ab. Im allgemeinen beträgt der Anteil an Prepolymeren in der Formulierung etwa 60 bis 95 %, vorzugsweise etwa 80 %.

Die erfindungsgemäß hergestellten Haftverschlußteile können in vielfältiger Weise eingesetzt werden: im Babywindelbereich oder für Inkontinenzwindeln, als temperaturbeständige Haftverschlußteile zur Befestigung von Schleifscheiben oder sonstiger Werkzeuge, zur großflächigen Befestigung von Teppichen, Wandbehängen, für Sitzbezüge und Sitzelemente, Verpackungen oder Fliegengitter sowie für selbstreinigende Oberflächen.

Die Dicke des Haftverschluß-Grundkörpers und die Anzahl der Verhakungsmittel pro cm^2 richten sich nach der Verwendung der fertigen Haftverschlußteile.

Neben Haftverschlußteilen können mit dem erfindungsgemäßen Verfahren auch andere Folien, die wenigstens einseitig hervorstehende Elemente oder Rippen umfassen, wie zum Beispiel Riblet-Folien, hergestellt werden. Riblet-Folien weisen auf einer Seite eine Vielzahl solcher hervorstehender Elemente auf, die eine Verminderung der Wandscherbeanspruchung und/oder eine Kontrolle der Grenzschichtablösung bewirken. Die hervorstehenden Elemente können entsprechend den gewünschten Effekten der Oberflächenstruktur in der Art einer Haifischhaut oder einer Lotus-Blüte geformt sein, die eine Verminderung des Strömungswiderstand bewirken und/oder selbstreinigend sind. Solche Oberflächenstrukturen sind beispielsweise in „Biological Surfaces and their Technological Application – Laboratory and Flight Experiments on Drag Reduction and Separation Control“ von D. W. Bechert, M. Bruse, W. Hage und R. Meyer in „Fluid Mech. (1997) Vol. 338, pp. 59 – 87 Cambridge University Press“ beschrieben.

Die Herstellung solcher Riblet-Folien erfolgt ebenfalls mittels der strahlenvernetzbare, insbesondere acrylierte Prepolymere umfassenden Formulierungen, wobei diese ebenfalls zwischen einer Formwalze und einer Gegendruckwalze entsprechend geformt und dann strahlengehärtet werden, wobei die Formwalze eine Vielzahl von der Riblet-Struktur komplementären Ausnehmungen aufweist. Die aus strahlenhärtbaren Formulierungen herstellbaren Riblet-Folien zeichnen sich

ebenfalls durch eine hohe Herstellungsgeschwindigkeit und eine außerordentlich große Temperaturbeständigkeit aus. Die Riblet-Folien werden beispielsweise zur Herabsetzung des Strömungswiderstandes bei Flugzeugen und Bahnen oder in Pipelines, zur Verhinderung der Eisbildung bei Flugzeugen oder als selbstreinigende Folie eingesetzt.

Die Erfindung wird nun anhand von Ausführungsbeispielen beschrieben.

Strahlenhärtbare Formulierungen zur Herstellung von Haftverschlußteilen

A. UV-härtbare Formulierungen

1. 77,7 Gew.% Ebecryl 4835(1) der Firma UCB Chemicals, Drogenbos, Belgien,

   9,7 Gew.% IRR 184(2) (Ethoxyethylacrylat) der Firma UCB Chemicals

   9,7 Gew.% HDDA(3) (Hexandioldiacrylat) der Firma UCB Chemicals

   2,9 Gew.% Darocur 1173(4) (Photoinitiator, 2-Hydroxy-2-methyl-1-phenyl-propan-1-on) der Firma Ciba Geigy

   Die Viskosität dieser Formulierung beträgt circa 300 mPa s.

2. 77.7 Gew.% Ebecryl(1) 4835 der Firma UCB Chemicals

   9,7 Gew.% IRR 184(2) der Firma UCB Chemicals

   9,7 Gew.% TMPTA(5) (Trimethylolpropantriacrylat) der Firma UCB Chemicals

   2.9 Gew.% Darocur 1173(4) der Firma Ciba Geigy als Photoinitiator

3. Anstelle von 9,7 Gew.% IRR 184 der Firma UCB Chemicals können in den Rezepturen 1 und 2 auch 9,7 Gew.% Isodecylacrylat der Fa. UCB Chemicals eingesetzt werden.

B. Elektronenstrahlhärtbare Formulierung

1. 80 Gew.% Ebecryl 4835 der Fa. UCB Chemicals

   10 Gew.% IRR 184 der Firma UCB Chemicals

   10 Gew.% HDDA (Hexandioldiacrylat) der Fa. UCB Chemicals

2. Anstelle von 10 Gew.% IRR 184 der Fa. UCB Chemicals werden 10 Gew.% Isodecylacrylat und/oder anstelle von 10 Gew.% HDDA 10 Gew.% TMPTA[(5)] eingesetzt.

(1) Ebecryl 4835 ist nach Herstellerangaben ein Gemisch aliphatischer Urethandiacrylate verdünnt mit 10 % Tetraethylenglykolacrylat. Die Viskosität beträgt bei 25 ° C etwa 4.500 mPa s. Das Molekulargewicht beträgt circa 1.600 g/mol.

(2) IRR 184 ist ein 2-(2-Ethoxyethoxy)ethylacrylat. Die Viskosität beträgt nach Herstellerangabe bei 25° C etwa 2,5 bis 9 mPa s.

(3) Die Viskosität des HDDA beträgt laut Herstellerangaben 10 mPa s.

(4) Darocur 1173 weist nach Herstellerangaben im Bereich zwischen 240 und 400 nm sich überlagernde Absorptionsbanden auf.

(5) Die Viskosität des Trimethylolpropantriacrylats beträgt laut Herstellerangaben 115 mPa s.

Nachfolgend werden zwei verschiedene Vorrichtungen zur Herstellung von Haftverschlußteilen beschrieben.

Es zeigt

Figur 1 eine Vorrichtung zur Herstellung von Haftverschlußteilen auf einem Trägermaterial mittels UV-Härtung

Figur 2 eine Vorrichtung zur Herstellung von Haftverschlußteilen ohne zusätzliches Trägermaterial mittels UV-Härtung.

Figur 3 eine Seitenansicht eines Ausschnitts aus einem Haftverschlußteil 26 auf einem Träger 13.

Bei der in Figur 1 gezeigten Vorrichtung wird die zu polymerisierende strahlenvernetzbare, insbesondere acrylierte Prepolymere umfassende Formulierung 14 gemäß Rezeptur A1, A2 oder A3 als ein Film 15 konstanter Schichtdicke zwischen d = 12 µm und 50 µm, vorzugsweise 22+/- 5 µm, auf ein Trägermaterial 13 aufgebracht, beispielsweise durch Rakel- 10 oder Düsenauftrag.

Als Trägermaterial 13 kann eine Folie aus Kunststoff, z. B. aus Hostaphan, ein Vlies, ein textiles Material oder jedes andere geeignete Trägermaterial eingesetzt werden.

Der Film 15 aus der zu polymerisierenden Formulierung auf dem Trägermaterial 13 wird anschließend einem Spalt 16 zwischen einer Formwalze 11 und einer Gegendruckwalze 12 zugeführt. Die Formwalze 11 weist eine Vielzahl von radial verlaufenden beidseitig offenen Ausnehmungen 17 auf. Die viskose Formulierung wird durch den Spalt 16 in Form eines Haftverschlußgrundkörpers 21 und in den Ausnehmungen in die Form der Verhakungsstege 22 und Verhakungsköpfe 23 umfassenden Verhakungsmittel 24 (vergleiche auch Figur 3) gepreßt und anschließend durch Bestrahlung mittels UV-Licht 19 geeigneter Wellenlänge bestrahlt. Die Verhakungsmittel können verschiedenartig geformt sein, beispielsweise eine runde, drei-, vier-, fünf- oder sechseckige Querschnittsfläche aufweisen. Auch die Verhakungsköpfe 23 können unterschiedlich geformt sein, beispielsweise tellerförmig, pilzförmig, gekrümmt oder hakenförmig. Dahingehende Ausgestaltungen sind in der nachveröffentlichten DE 198 28 856.5 beschrieben.

Durch die Absorption des UV-Lichts setzt der UV-empfindliche Photoinitiator Radikale frei, die die Radikalkettenpolymerisation starten.

Die Reaktionsgeschwindigkeit der Polymerisationsreaktion ist außerordentlich hoch, so daß die aus dem Haftverschlußgrundkörper 21 und den Verhakungsmitteln 24 bestehenden Haftverschlußteile 26 auf dem Trägermaterial 13 von der Formwalze 11 in einem Bruchteil der herkömmlichen Aushärtungszeit mittels der Abzugswalze 20 gelöst werden können. Pro Minute können ca. 20 bis 30 m Haftverschlußfolie hergestellt werden. Da gegenüber den bekannten Verfahren geringere Linien-Quetschdrücke erforderlich sind, kann die Vorrichtung bei gleichbleibender Genauigkeit breitere Walzen 11, 12, 20 aufweisen.

Durch den Linien-Quetschdruck zwischen den Walzen 11 und 12 und die UV-Bestrahlung wird ebenfalls eine feste Verbindung zwischen dem Trägermaterial 13 und dem Haftverschlußgrundkörper 21 erreicht.

Um eine vollständige Versorgung der in der Formwalze 11 vorgesehenen Ausnehmungen 17 zu erreichen, wird die Formulierung in einem geringen Überschuß zugegeben, so daß durch den Wulst 25 aus strahlenvernetzbarer Masse 14 immer genügend Ausgangsmaterial zur Versorgung der Ausnehmungen 17 in der Formwalze 11 zur Verfügung steht.

Die Gegendruckwalze 12 und die Walze 20 weisen eine der Drehrichtung der Formwalze 11 entgegengesetzte Drehrichtung auf.

Als UV-Quelle 19 kann ein Quecksilber-Mitteldruckstrahler verwendet werden. Es sind jedoch auch andere UV-Strahlungsquellen möglich. In Abhängigkeit von der die Radikalbildung bewirkenden Absorptionsbande des Photoinitiators wird mit UV-Licht im Wellenlängenbereich zwischen 180 und 400 nm entsprechend circa 3 bis 6 eV bestrahlt.

Die Bestrahlungswellenlänge richtet sich nach dem Emissionsspektrum der verwendeten UV-Strahlungsquelle und nach dem Absorptionsband der Photoinitiatoren.

Das verwendete Trägermaterial 13 sollte selbstverständlich gegenüber der UV-Strahlung weitgehend beständig sein. Darüber hinaus muß trotz der durch das Trägermaterial bewirkten Filterung und Streuung der UV-Strahlung sichergestellt sein, daß in der zu härtenden Schicht genügend die Kettenreaktion in Gang setzende photochemische erzeugte Primärradikale gebildet werden.

Die in **Figur 2** gezeigte Vorrichtung dient im Unterschied zu der in Fig. 1 ausführlich beschriebenen Vorrichtung zur Herstellung von Haftverschlußteilen ohne zusätzliches Trägermaterial. Die strahlenvernetzbare Formulierung 14 befindet sich in einem Vorratsbehälter 31 und wird über eine Düse 32 dem Spalt 16 zwischen der Formwalze 11 und der Gegendruckwalze 12 zugegeben, wobei die Zugabe wie bei der in Figur 1 beschriebenen Vorrichtung in einem geringen Überschuß erfolgt.

Durch die hohe Viskosität der strahlenvernetzbaren Formulierung bleibt die durch den Anpreßdruck bewirkte Verformung der viskosen Masse aufrechterhalten, bis eine weitgehende Aushärtung durch die Bestrahlung erfolgt ist und die Haftverschlußteile mittels der Abzugswalze 20 von der Formwalze 11 gelöst werden.

Bei Einsatz von acrylierten Urethanen als Prepolymeren ist es nicht es nicht erforderlich, unter Schutzgas zu arbeiten. Um einen im wesentlichen durch Sauerstoff bewirkten vorzeitigen Kettenabbruch bei Verwendung anderer strahlenhärtbarer Prepolymere zu vermeiden, sollte die Reaktion unter Schutzgas durchgeführt werden.

Bei einer Vorrichtung zur Herstellung von Haftverschlußteilen durch Elektronenstrahlenhärtung wird anstelle der UV-Quelle 19 in den in Figur 1 und 2 beschriebenen Vorrichtungen eine Elektronenstrahlungsquelle eingesetzt und beispielsweise eine der Formulierungen B1 oder B2 als strahlenvernetzbare Masse verwendet.

Der Energiebereich der Elektronenstrahlung liegt üblicherweise zwischen 150 und 300 keV.

Die Herstellung der Haftverschlußteile aus strahlenvernetzbaren, insbesondere acrylierten Prepolymeren kann auch in anderen kontinuierlich oder diskontinuierlich arbeitenden Vorrichtungen erfolgen, die Mittel zum Verformen, Gießen und/oder Pressen von strahlenvernetzbare, insbesondere acrylierte Prepolymere umfassenden Formulierungen in Form eines Haftverschlußgrundkörpers mit daran angeordneten Verhakungsmitteln aufweisen und die eine UV- oder einen Elektronenstrahlungsquelle zur Strahlenhärtung umfassen.

Patentansprüche

1. Verfahren zur Herstellung von Haftverschlußteilen mit einer Vielzahl von Verhakungsmitteln (24), dadurch gekennzeichnet, daß eine strahlenvernetzbare Prepolymere umfassende Formulierung in Form einer Vielzahl von Verhakungsmitteln (24) zusammen mit einem Haftverschluß-Grundkörper (21) geformt, gegossen und/oder gepreßt und anschließend strahlengehärtet wird.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die strahlenvernetzbaren, insbesondere acrylierten Prepolymere aus der aus Polyesteracrylaten, Epoxyacrylaten, Polyetheracrylaten, Silikonacrylaten oder Urethanacrylaten bestehenden Gruppe ausgewählt werden, wobei die Urethanacrylate vorzugsweise aliphatische mono-, bi- oder trifunktionelle Urethanacrylate sind.

3. Verfahren nach einem der Ansprüche 1 oder 2, dadurch gekennzeichnet, daß die Formulierung Reaktivverdünner, vorzugsweise Monomere, besonders bevorzugt Acrylate, umfaßt, wobei die Acrylate vorzugsweise monofunktionelle Acrylate aus der aus Butylacrylat, 2-Ethylhexylacrylat, Hydroxyethylacrylat, Hydroxypropylacrylat, 4-Hydroxybutylacrylat, Ethyldiglykolacrylat, Isodecylacrylat und 2-Ethoxyethylacrylat bestehenden Gruppe, die bifunktionellen Acrylate aus der aus Diethylenglykoldiacrylat, Dipropylenglykoldiacrylat, Triethylenglykoldiacrylat, Tripropylenglykoldiacrylat und 1,6-Hexandioldiacrylat und

die trifunktionellen Acrylate aus der aus Trimethylolpropantriacrylat oder Pentaerythrittriacrylat bestehenden Gruppe sind und 2-Ethoxyethylacrylat, Isodecylacrylat, 1,6-Hexandioldiacrylat und Trimethylolpropantriacrylat besonders bevorzugt sind.

4. Verfahren nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß die Strahlenhärtung mittels Elektronenstrahlung erfolgt.

5. Verfahren nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß die Strahlenhärtung mittels UV-Strahlen erfolgt und die Formulierung vorzugsweise zusätzlich wenigstens einen Photoinitiator umfaßt.

6. Verfahren nach Anspruch 5 , dadurch gekennzeichnet, daß der Photoinitiator aus der aus α–Hydroxyketonen, α–Aminoketonen, Benzildimethylketalen, Bisbenzoyl-phenylphoshinoxiden, Metallocenen und deren Derivaten bestehenden Gruppe ausgewählt wird und vorzugsweise 2-Hydroxy-2-methyl-1-phenylpropan-1-on ist.

7. Verfahren nach einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß das Formen, Gießen oder Pressen in einem Spalt (16) zwischen einer Formwalze (11) und einer Gegendruckwalze (12) erfolgt und die Formwalze (11) eine Vielzahl von radial verlaufenden Ausnehmungen (17) aufweist, wobei bei Passieren des Spaltes (16) die Verhakungsmittel (24) bzw. die hervorstehenden Elemente gebildet werden.

8. Verfahren nach Anspruch 7, dadurch gekennzeichnet, daß die Viskosität der Formulierung bei 25° C zwischen 150 und 20.000 mPa s, vorzugsweise zwischen 300 und 5.000 mPa s, beträgt.

9. Vorrichtung zur Herstellung von Haftverschlüssen nach einem der Ansprüche 1 bis 8, dadurch gekennzeichnet, daß die Vorrichtung Zuführmittel (32, 10) für die strahlenvernetzbare, insbesondere acrylierte Prepolymere umfassende Formulierung (14), wenigstens eine Formwalze (11) und eine Gegendruckwalze (12) umfaßt und die Formwalze(11) eine Vielzahl von radial verlaufenden Ausnehmungen (17) aufweist und eine UV- (19) oder eine Elektronenstrah-

lungsquelle zur Strahlenhärtung der geformten strahlenhärtbaren Formulierung vorgesehen ist.

Fig. 1

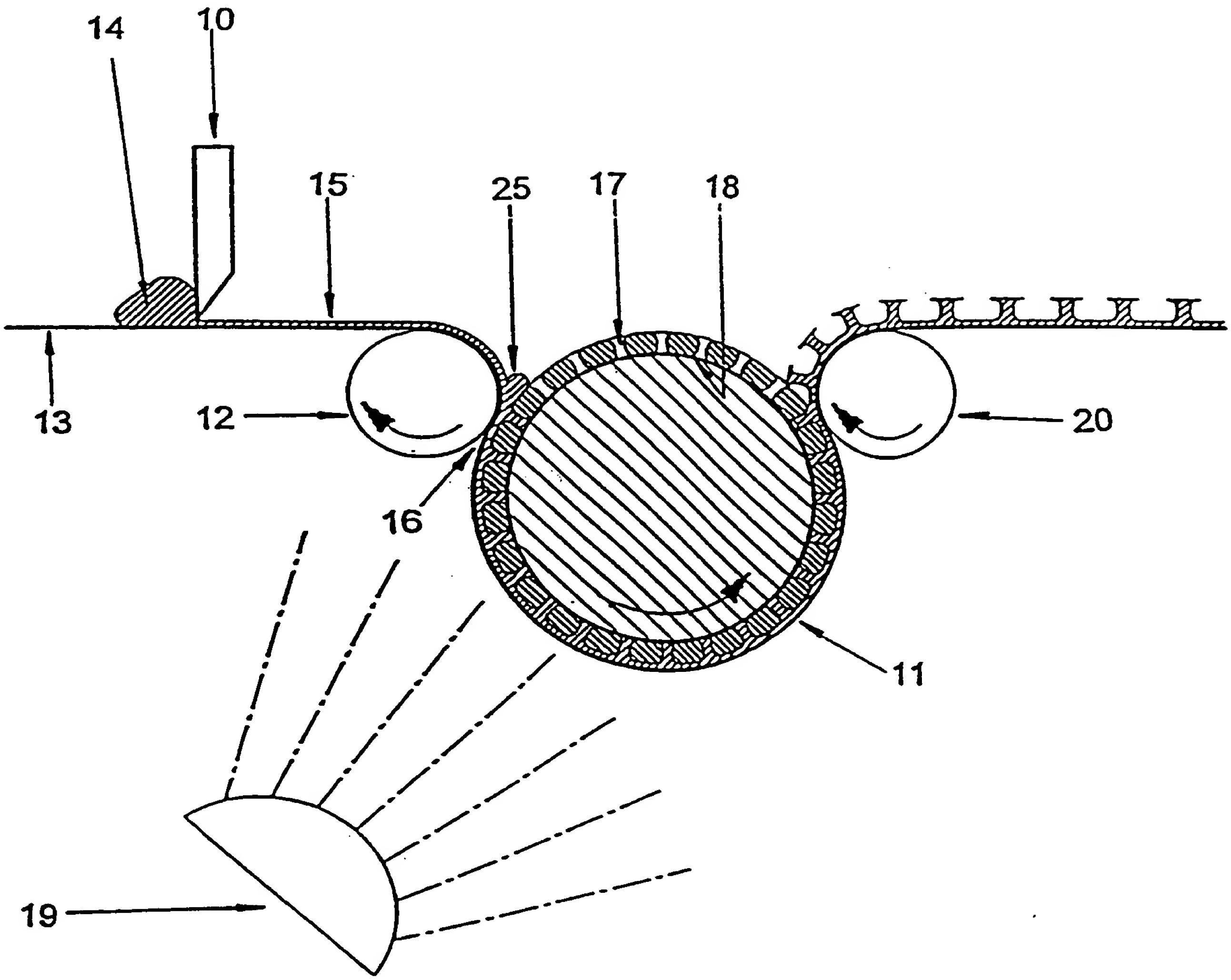
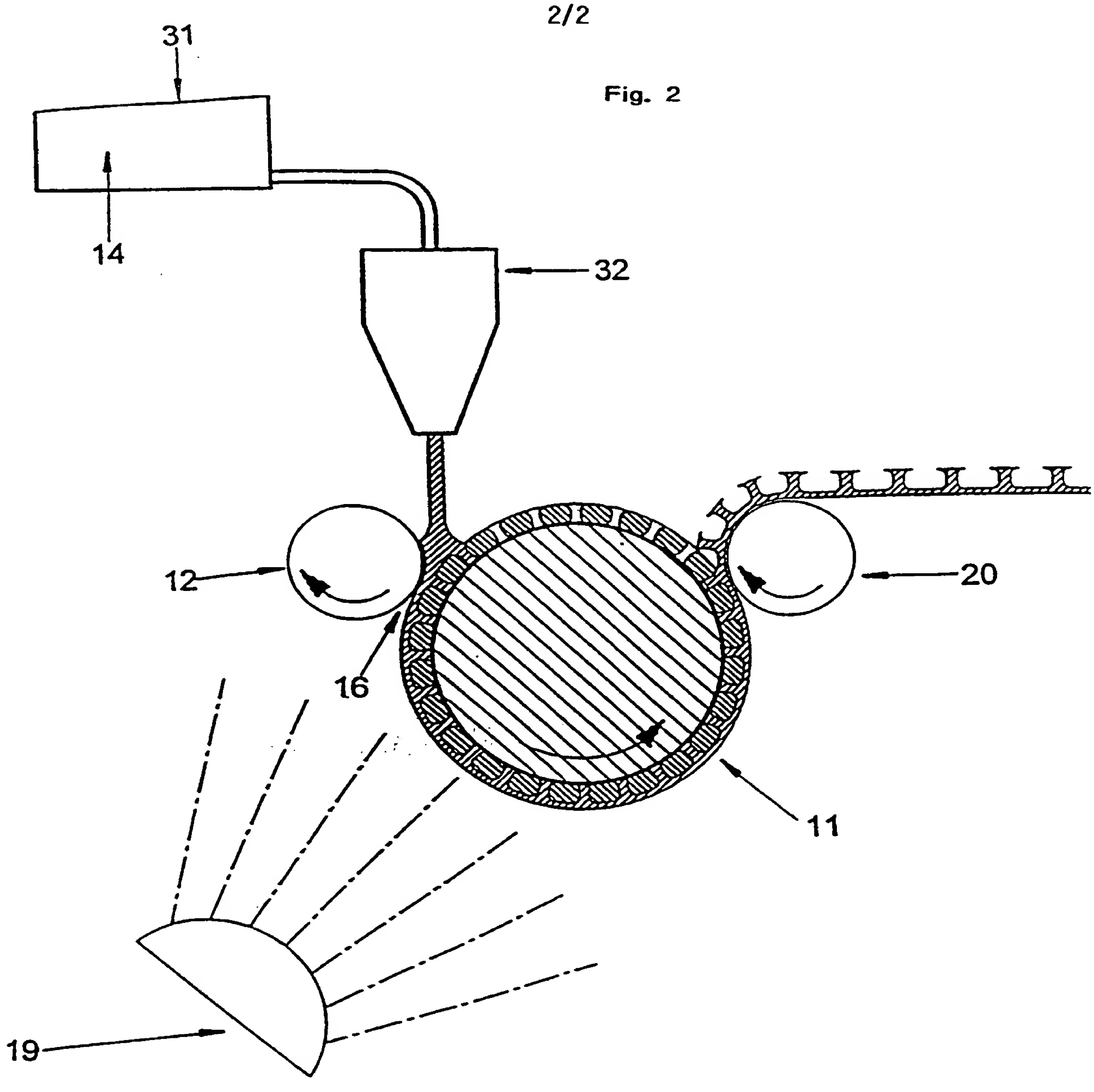


Fig. 2



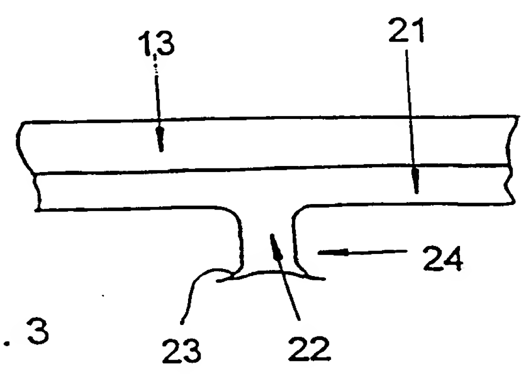


Fig. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 00/00486

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B29C43/22 A44B18/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B29C A44B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 785 784 A (CHESLEY JASON A ET AL) 28 July 1998 (1998-07-28) column 13, line 48 - line 62; figure 5	1-5,7,9
A	EP 0 408 283 A (CANON KK) 16 January 1991 (1991-01-16) claim 1; figure 1	1
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 272 (M-1610), 24 May 1994 (1994-05-24) & JP 06 047883 A (TOPPAN PRINTING CO LTD), 22 February 1994 (1994-02-22) abstract	1

☐ Further documents are listed in the continuation of box C.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 April 2000	02/05/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Attalla, G

Form PCT/ISA/210 (second sheet) (July 1992)

INTE ATIONAL SEARCH REPORT

Information on patent family members

Intern al Application No

PCT/EP 00/00486

Patent document cited in search report	Publication date	Patent family member(s)	Publication dat
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		US 5607345 A	04-03-1997
		AU 692828 B	18-06-1998
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		BR 9506493 A	07-10-1997
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		EP 0739263 A	30-10-1996
		ES 2130590 T	01-07-1999
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INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
PCT/EP 00/00486

A. KLASSIFIZIERUNG DES ANMELDUNGSGEGENSTANDES
IPK 7 B29C43/22 A44B18/00

Nach der Internationalen Patentklassifikation (IPK) oder nach der nationalen Klassifikation und der IPK

B. RECHERCHIERTE GEBIETE

Recherchierter Mindestprüfstoff (Klassifikationssystem und Klassifikationssymbole)
IPK 7 B29C A44B

Recherchierte aber nicht zum Mindestprüfstoff gehörende Veröffentlichungen, soweit diese unter die recherchierten Gebiete fallen

Während der internationalen Recherche konsultierte elektronische Datenbank (Name der Datenbank und evtl. verwendete Suchbegriffe)

C. ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie°	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
X	US 5 785 784 A (CHESLEY JASON A ET AL) 28. Juli 1998 (1998-07-28) Spalte 13, Zeile 48 - Zeile 62; Abbildung 5	1-5,7,9
A	EP 0 408 283 A (CANON KK) 16. Januar 1991 (1991-01-16) Anspruch 1; Abbildung 1	1
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 272 (M-1610), 24. Mai 1994 (1994-05-24) & JP 06 047883 A (TOPPAN PRINTING CO LTD), 22. Februar 1994 (1994-02-22) Zusammenfassung	1

☐ Weitere Veröffentlichungen sind der Fortsetzung von Feld C zu entnehmen

☒ Siehe Anhang Patentfamilie

° Besondere Kategorien von angegebenen Veröffentlichungen :
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Datum des Abschlusses der internationalen Recherche	Absendedatum des internationalen Recherchenberichts
20. April 2000	02/05/2000

Name und Postanschrift der Internationalen Recherchenbehörde	Bevollmächtigter Bediensteter
Europäisches Patentamt, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Attalla, G

1

INTERNATIONALER RECHERCHENBERICHT

Angaben zu Veröffentlichungen, die zur selben Patentfamilie gehören

Internationales Aktenzeichen
PCT/EP 00/00486

Im Recherchenbericht angeführtes Patentdokument	Datum der Veröffentlichung	Mitglied(er) der Patentfamili	Datum der Veröffentlichung
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		US 5480596 A	02-01-1996
JP 06047883 A	22-02-1994	KEINE	

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

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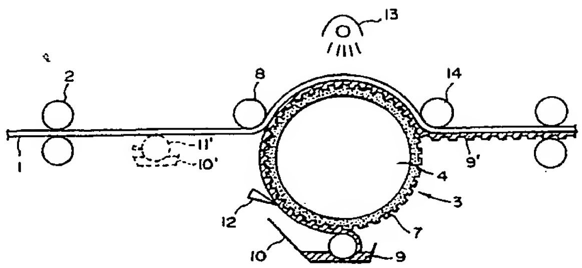
(54) Apparatus for producing substrate sheet for optical recording mediums and process for producing substrate sheet for optical recording mediums making use of it, and apparatus for producing optical recording medium and process for producing optical recording medium making use of it.

(57) The present invention relates to an apparatus for producing a substrate sheet for optical recording medium and a process for producing a substrate sheet by the use of the apparatus. The apparatus comprises a means for forming an photo-curable resin layer on at least one of a substrate sheet and a roll stamper having thereon a pattern corresponding with preformatting information; a means for bringing the substrate sheet into close contact with the roll stamper, interposing the photo-curable resin layer between them; and a means for curing said photo-curable resin layer; the roll stamper being so formed as to undergo elastic deformation.

The present invention also relates to an apparatus for producing an optical recording medium and a process for producing an optical recording medium by the use of the apparatus. The apparatus comprises continuously; a means for melting a resin and extruding the molten resin to form a resin sheet; a means for forming a photo-curable resin layer on at least one of a substrate sheet and a roll stamper having thereon a pattern corresponding with preformatting information; a means for bringing the substrate sheet into close contact with the roll stamper, interposing the photo-curable resin layer between them; a means for curing said photo-curable resin layer; a means for peeling from the roll stamper the substrate sheet on which a photo-cured resin layer has been fixed; a means for forming a recording layer on the surface of the substrate sheet on which the pattern has been formed; a means for forming a protective member on the surface on which the recording layer has been formed; and a means for individually cutting the substrate sheet having said recording layer and protective member; the roll stamper being so formed as to undergo elastic de-

EP 0 408 283 A2

formation.



F I G. 2

APPARATUS FOR PRODUCING SUBSTRATE SHEET FOR OPTICAL RECORDING MEDIUMS AND PROCESS FOR PRODUCING SUBSTRATE SHEET FOR OPTICAL RECORDING MEDIUMS MAKING USE OF IT, AND APPARATUS FOR PRODUCING OPTICAL RECORDING MEDIUM AND PROCESS FOR PRODUCING OP ICAL RECORDING MEDIUM MAKING USE OF IT

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an apparatus for continuously producing a substrate sheet for optical recording mediums used in optically recording and reproducing information using a laser beam or the like. It also relates to a process for continuously producing a substrate sheet for optical recording mediums by the use of the apparatus. The present invention further relates to an apparatus for producing an optical recording medium, and a process for producing an optical recording medium by the use of the apparatus.

Related Background Art

In optical recording mediums such as optical disks and optical cards, optically detectable minute pits of several µm, for example, from 1 µm to 10 µm, are formed in a track on a thin recording layer provided on a substrate, and thus information can be recorded in a high density. In such optical recording mediums, a laser beam must be scanned along the track when the information is recorded and reproduced. For this purpose, a substrate with guide grooves for tracking is commonly used.

Methods of preparing such guide grooves or a substrate provided with guide grooves are known to include a compression molding process in which a softened plastic material is pressed using a stamper followed by curing, an injection molding process in which a molten plastic material is injected into a mold provided with a stamper followed by curing, and a 2P (photo-polymerization) process in which guide grooves are transferred from a stamper by the use of a photopolymer. Of these, the 2P process is one of superior processes for preparing substrates in view of the advantages that guide grooves can be readily transferred, substrates have a good solvent resistance, and substrates can be made to have less optical distortion.

More specifically, the superior solvent resistance of a substrate is advantageous when a recording layer is formed by coating, using an organic material as a recording material. For example, when a substrate is prepared by the 2P process, it is possible to use a solvent that can not be used in a substrate comprised of usual plastics such as acrylate and polycarbonate because of its power to dissolve the surface of the substrate. Hence, it becomes possible to use a recording material having a good solubility to the solvent, so that the recording material can be selected from a vast range of materials. The 2P process also has a great advantage that it requires only a very little investment in equipment, compared with other processes.

Compared with other processes, however, the 2P process requires a longer production time per sheet of substrates, and has been involved in the problem that it is not suited for mass-production. Under such circumstances, a proposal, as disclosed in Japanese National Publication (of translated version) No. 62-506504, has been made on a technique by which, using a master on which patterns of pits or grooves have been formed, the patterns are transferred and formed on a film substrate so that substrates for film-like optical recording mediums can be continuously produced.

A conventional method for producing substrates for optical recording mediums will be described below with reference to the accompanying drawing. Fig. 4 illustrates the structure of an apparatus used in forming guide grooves on a substrate according to a conventional method. In Fig. 4, a substrate sheet 1 fed from feed rolls 2 is delivered along the circumference of a roll stamper 3 on which guide grooves or preformat patterns corresponding with information are formed. A nip roll 8 has the function of pressing the substrate sheet 1 against the surface of the roll stamper 3. A resin tank 10 containing a liquid ultraviolet-curable resin 9, curable as a result of exposure to ultraviolet rays, is provided beneath the roll stamper 3. In this resin tank 10, a coating roll 11 is provided which rotates in pressure contact with the roll stamper 3. The liquid ultraviolet-curable resin 9 is coated by this coating roll 11 on the surface of the roll stamper 3. The ultraviolet-curable resin 9 thus coated is held between the substrate sheet 1 and the roll stamper 3 by the action of the nip roll 8. An ultraviolet lamp 13 is provided above the nip roll 8, and the ultraviolet-curable resin 9 held between the substrate sheet 1 and the roll stamper 3 is irradiated with ultraviolet rays so that the ultraviolet-curable resin is cured. A delivery roll 14 has the function of peeling from the roll stamper 3 the substrate sheet 1 and the layer of the ultraviolet-curable resin having been cured in a fixed state to

the substrate sheet. Thus, preformat patterns of optical disks are transferred to the substrate sheet.

When, however, the ultraviolet-curable resin and the substrate are laminated according to the above method, the coating surface of the resin and the substrate are in liquid-solid contact, and there has been involved in the problem that bubbles tend to be included when they are brought into contact.

Moreover, guide grooves of the roll stamper or preformat patterns corresponding with information are required to be formed in an accuracy of a submicroscopic order. It, however, has been not so easy to eliminate, in a greater accuracy, rotational irregularities of a DC motor for driving the roll stamper and rotational irregularities caused by gears. This has been one of the causes of the troubles that may bring about eccentricities, defects and recording errors of recording mediums.

SUMMARY OF THE INVENTION

The present invention was made in view of the above problems. Accordingly, an object of the present invention is to provide an apparatus for producing continuously and in a high productivity a substrate sheet for optical recording mediums, that employs as the roll stamper a roll stamper capable of undergoing elastic deformation, thereby preventing bubbles from being included in a photo-curable resin layer and between the photo-curable resin layer and the substrate sheet, and is improved in the follow-up action between a roll stamper and a substrate sheet so that the rate of errors can be decreased, and also to provide a process for producing the substrate sheet making use of such an apparatus.

Another object of the present invention is to provide an apparatus, and a process, for producing continuously and in a high productivity optical recording mediums, that can prevent bubbles from being included in a photo-curable resin layer and between the photo-curable resin layer and the substrate sheet, thereby decreasing the rate of errors.

The apparatus of the present invention for producing a substrate sheet for optical recording mediums is an apparatus comprising;

a means for forming an photo-curable resin layer on at least one of a substrate sheet and a roll stamper having thereon a pattern corresponding with preformatting information;

a means for bringing the substrate sheet into close contact with the roll stamper, interposing said photo-curable resin layer between them; and

a means for curing said photo-curable resin layer;

said roll stamper being so formed as to undergo elastic deformation.

The process of the present invention for producing a substrate sheet for optical recording mediums is a process comprising the steps of;

forming an photo-curable resin layer on at least one of a substrate sheet and a roll stamper having thereon a pattern corresponding with preformatting information;

bringing the substrate sheet into close contact with the roll stamper, interposing said photo-curable resin layer between them;

irradiating said photo-curable resin layer with light to transfer said pattern to the photo-curable resin layer, and at the same time fixing said photo-curable resin layer to the substrate sheet; and

peeling from the roll stamper the substrate sheet on which a photo-cured resin layer has been fixed;

said roll stamper being so formed as to undergo elastic deformation.

The apparatus of the present invention for producing an optical recording medium is an apparatus comprising continuously;

a means for melting a resin and extruding the molten resin to form a resin sheet;

a means for forming a photo-curable resin layer on at least one of a substrate sheet and a roll stamper having thereon a pattern corresponding with preformatting information;

a means for bringing the substrate sheet into close contact with the roll stamper, interposing said photo-curable resin layer between them;

a means for curing said photo-curable resin layer;

a means for peeling from the roll stamper the substrate sheet on which a photo-cured resin layer has been fixed;

a means for forming a recording layer on the surface of the substrate sheet on which said pattern has been formed;

a means for forming a protective member on the surface on which said recording layer has been formed; and

a means for individually cutting said substrate sheet having said recording layer and protective member;

said roll stamper being so formed as to undergo elastic deformation.

The process of the present invention for producing an optical recording medium is a process comprising continuously the steps of;

melting a resin and extruding the molten resin to form a resin sheet;

forming a photo-curable resin layer on at least one of a substrate sheet and a roll stamper having thereon a pattern corresponding with preformatting information;

bringing the substrate sheet into close contact with the roll stamper, interposing said photo-curable resin layer between them;

curing said photo-curable resin layer to fix the layer to said substrate sheet;

peeling from the roll stamper the substrate sheet on which a photo-cured resin layer has been fixed;
forming a recording layer on the surface of the substrate sheet on which said pattern has been formed;
forming a protective member on the surface on which said recording layer has been formed; and
individually cutting said substrate sheet having said recording layer and protective member;
said roll stamper being so formed as to undergo elastic deformation.

Referring again to the prior art, U.S. Patent No. 3,636,147 and Japanese Patent Publication No. 20694/1988 disclose that a roll having an elastic surface is used as a press roll used in embossing on a resin sheet. In the manufacture of an optical recording medium using a 2P resin, however, the 2P resin is in a liquid state, and hence no step is provided in which a great pressure is applied as in the molding of the above resin film. Thus, there has been no 2P molding in which a roll stamper is so constituted as to undergo elastic deformation. The present inventors have found that in the manufacture of a substrate sheet according to the 2P molding, for an optical recording medium having a very fine and regular pattern of preformatting information, employment of a roll stamper capable of undergoing elastic deformation makes it possible for bubbles to be greatly suppressed from occurring when a substrate sheet is brought into close contact with a roll stamper interposing a photo-curable resin layer between them. The present invention has been thus accomplished.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1 and 2 illustrate preferred embodiments of the apparatus of the present invention for producing a substrate sheet for optical recording mediums.
Fig. 3 schematically illustrates an embodiment of the apparatus of the present invention for producing optical recording mediums.
Fig. 4 schematically illustrates a conventional process for optical recording mediums according to the 2P process.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be described below in detail with reference the drawings.

In the present invention, a roll stamper capable of undergoing elastic deformation is used as the roll stamper so that bubbles can be readily prevented from their inclusion in a photo-curable resin layer held between the substrate sheet and the roll stamper. In addition, the follow-up of the roll stamper to the substrate sheet is improved against fine rotational irregularities or vibrations so that medium errors can be readily decreased.

Fig. 1 illustrates the constitution of an example of the apparatus of the present invention, used in the process for continuously producing a substrate for optical recording mediums. In Fig. 1, a substrate sheet 1 is so constituted as to be fed from feed rolls 2. There are no particular limitations on the substrate sheet 1 so long as it is flexible. For example, it is possible to suitably use plastic sheets made of polycarbonate, an acrylic resin, a polyolefin resin, a polyester resin, an epoxy resin or the like. A primer layer may also be formed on the surface of the substrate sheet 1 in order to increase the adhesion to a photo-curable resin 9.

A roll stamper 3 has patterns formed on its surface, corresponding with preformatting information, and is so constituted as to undergo elastic deformation when brought into close contact with the substrate sheet 1, interposing the photo-curable resin layer.

A resin tank 10 holding therein a liquid photo-curable resin 9 which is curable as a result of irradiation with, e.g., ultraviolet rays is provided below the roll stamper 3. In this resin tank 10, a coating roll 11 that rotates in pressure contact with the surface of the roll stamper 3 is provided so that the photo-curable resin 9 in a liquid state is applied to the surface of the roll stamper 3. A resin layer 9′ thus formed by coating is regulated with a blade 12 to have a uniform thickness, and then held between the substrate sheet 1 and the roll stamper 3 by means of a nip roll 8.

Subsequently, using an ultraviolet lamp provided above the roll stamper 3, the photo-curable resin layer held between the substrate sheet 1 and the roll stamper 3 is irradiated with ultraviolet rays so that the photo-curable resin is cured. Then, a photo-cured resin layer 9′ thus formed is peeled from the roll stamper 3 by the aid of a delivery roll 14. Thus a substrate sheet for optical recording mediums can be obtained in which the preformat patterns of stampers have been transferred to the photo-curable resin layer on the substrate sheet.

In the present invention, the roll stamper capable of undergoing elastic deformation can be prepared in the manner, for example, as shown in Fig. 1, where an elastic material layer (an elastomer layer) 5 is provided on the periphery of a core 4 made of a metal to form an elastic roll, and then a flat-sheet stamper 6 made of Ni, of from 0.1 to 0.3 mm in thickness, is adhered with an adhesive or mechanically fixed with screws or the like on the periphery of the elastic roll along its surface. Thickness of the elastomer layer 5 may vary depending on the materials used, and may preferably

be usually in the range of from 0.1 to 100 mm, and particularly from 0.5 to 50 mm.

The elastic material used here should have a smaller hardness than at least the metal core 4. Specifically, it may preferably has an hardness of from 5 to 100, and particularly from 10 to 80, according to JIS-A hardness so that the patterns can be transferred in a high accuracy and also no bubbles may be included in the photo-curable resin layer or at the interface between the photo-curable resin layer and the substrate sheet when the substrate sheet is brought into close contact with the roll stamper. Materials therefor specifically include, for example, elastomers such as polyurethanes, natural rubber, isoprene rubber, chloroprene rubber, and silicone rubber.

The roll stamper can also be prepared in the manner as shown in Fig. 2, where on the periphery of a core 4 made of a metal a stamper 7 comprising an elastic material is adhered along its surface or directly set and molded on the core.

The stamper used here, comprising an elastic material, includes, for example, stampers made of elastic resins such as silicone resin and fluorine resin. The stamper used here may preferably have a thickness of from 0.1 to 50 mm, and particularly from 0.5 to 10 mm. It also may preferably have a hardness of from 10 to 100, and particularly from 30 to 90, according to JIS-A hardness, from the viewpoint of good transfer of patterns and prevention of inclusion of bubbles.

In the preformat pattern formed on the roll stamper, that corresponds with preformatting information, the preformatting information refers to, for example, tracking grooves and/or encoded information in the form of readable marks. It specifically refers to a spiral track groove for an optical disk, having dimensions of, for example, a width of from 0.2 μm to 3.0 μm and particularly from 0.5 μm to 2 μm, and a pitch of from 0.1 μm to 15.0 μm and particularly from 1.0 μm to 5 μm; stripe-like track grooves for an optical card, of a width of from 1 μm to 10 μm and particularly from 2 μm to 5 μm, and an interval of from 5 μm to 20 μm and particularly from 8 μm to 15 μm; or rectangular minute information pits of a length of 10 μm or less and a width of 10 μm or less, or elliptical information pits of a major axis of 10 μm or less.

As materials for the metal core used in the present invention, it is possible to use metal semiconductors, dielectrics or alloys, and particularly preferably aluminum, hard metals, diecast metals, etc. which can be readily mirror-finished. Or steel can be particularly preferably used.

The outer diameter of the roll stamper may vary depending on the material and thickness of the substrate sheet 1. For example, when an optical disk using a 1.2 mm thick polycarbonate is taking into account, the roll stamper 3 may preferably have a diameter of not less than 300 mm. It may preferably have a diameter of not less than 150 mm even when an optical disk made of a 0.4 mm thick polycarbonate is taken into account.

In Fig. 1, the photo-curable resin 9 in a liquid state is applied to the surface of the roll stamper 3 by means of the coating roll 11 that rotates in pressure contact with the surface of the roll stamper 3. The liquid resin thus applied is regulated with the blade 12 to have a uniform thickness, and then held between the substrate sheet 1 and the roll stamper 3 by means of a nip roll 8. In the present invention, the photo-curable resin layer may not be applied only to the surface of the roll stamper 3, and may alternatively applied to the surface at which the substrate sheet is opposed to the roll stamper. Still alternatively, it may also be applied to both the surfaces of the substrate sheet 1 and the roll stamper 3. In the case when the photo-curable resin is applied to both the surfaces of the substrate sheet 1 and the roll stamper 3, the step of adhering the substrate sheet to the roll stamper 3 is carried out in liquid-liquid contact, so that the bubbles can be much better suppressed from generation when the substrate sheet and roll stamper are brought into close contact, also bringing about an improvement in adhesion. This is hence preferred. In this instance, the photo-curable resin may preferably be applied to the substrate sheet 1 and/or the roll stamper 3 in a coating thickness of from 0.1 to 50 μm, and particularly from 1 to 30 μm, in order to prevent the substrate from its warpage due to cure shrinkage and improve transfer performance of preformat patterns.

The photo-curable resin 9 used in the present invention includes, for example, an ultraviolet-curable resin and an electron ray-curable resin.

The ultraviolet-curable resin that can be used includes prepolymers, oligomers and monomers, having an unsaturated bond in the molecule. For example, it is possible to use a mixture of i) one or more kinds of an unsaturated polyester, an acrylate such as epoxy acrylate, urethane acrylate or polyether acrylate, and a methacrylate such as epoxy methacrylate, urethane methacrylate, polyether methacrylate or polyester methacrylate and ii) a photopolymerizable monomer having an unsaturated bond in the molecule, as exemplified by a functional monomer such as dicyclopentenyl acrylate, 1,3-butanediol acrylate, polyethylene glycol diacrylate or pentaerythritol acrylate. A radical-generating compound such as a halogenated acetophenone, benzophenone, benzoin, benzoin ether, Michler's ketone, benzyl, benzyl dimethyl ketal, tetramethylthiuram monosulfide or a thioxazone may also be used as a polymerization initiator. These may be any of those which can be

readily peeled from a stamper when cured, and also can be well matched to a recording layer. There are no particular limitations on the coating of the liquid photo-curable resin 9 on the roll stamper 3, and the coating roll 11 may be replaced by a dispenser nozzle or any other conventional coating means used in printing, from which a suitable means may be selected depending on the viscosity and coating thickness.

In the present invention, the step of forming the substrate sheet 1 by extrusion is provided, as shown in Fig. 3, before the step of transferring the pattern of preformatting information to the substrate sheet 1 having thereon the above photo-curable resin. After the step of peeling the substrate sheet to which the patterns corresponding with preformatting information have been transferred, steps are also continuously provided, including the step of forming a recording layer on the surface of a photo-cured resin layer on which the preformat pattern has been formed, the step of forming a protective layer on the recording layer, and the step of cutting the sheet into individual optical recording mediums. Thus, optical recording mediums having a high reliability can be produced in a good mass-productivity and at a low cost.

These steps will be detailed below with reference to Fig. 3.

In Fig. 3, the numeral 31 denotes an extruder, into which pellets of the material for a substrate sheet 1 are put from a hopper 30. A molten resin is extruded in the form of a belt from a T-die connected to the extruder. With approach to an outlet of the T-die, the resin is lead to the gap between a roll 32 and a roll 33. A mirror surface is transferred to the underside surface of the substrate sheet 1 through means of a mirror-surface roll 33, and then a mirror surface is also transferred to another surface of the substrate sheet through means of a mirror-surface roll 34. The substrate sheet is thus formed.

Here, the molten resin extruded from the T-die in a sheet is held between the rolls 32 and 33 under pressure, so that the mirror surfaces are formed on its surfaces. At this time, the resin sheet may preferably be in a state near to molten as far as possible in order to carry out good transfer. Hence, the distance between the T-die and the point at which the resin sheet is pressed between the rolls 32 and 33 may preferably be not more than 50 cm, and particularly not more than 20 cm. The temperature in the surrounding atmosphere in that course may preferably be not lower than 60° C.

The resin sheet serving as the substrate sheet of the present invention may have a thickness variable with variations of the space between the rolls 32 and 33. In view of the advantages that little strain may be produced inside the resin sheet, the resin sheet may preferably have a thickness of from 0.2 mm to 2.0 mm, and particularly from 0.3 mm to 1.5 mm. A thickness less than 0.2 mm may cause rapid cooling of the resin sheet, resulting in an insufficient transfer. On the other hand, a thickness more than 2.0 mm tends to cause strain in the sheet.

The rolls 32, 33 and 34, on which the thickness of this sheet depends, are so set as to be as parallel as possible to each other in order to prevent the irregularities in sheet thickness that may cause errors in recording and reproduction. Stated specifically, assuming as θ the angle formed by the axis of each roll, it is preferred that $\tan\theta$ is 5×10^{-3} or less, and particularly 1×10^{-3} or less.

The extrusion speed of the resin sheet and the peripheral speeds of a roll stamper 3, the mirror-surface rolls 33, 34 and coaters 11, 35 may preferably be set equal. This is because no stress such as stretch is applied to the resin sheet and hence a resin sheet free from double refraction or the like and with superior optical characteristics can be obtained.

Next, the substrate sheet 1 thus formed is coated with a photo-curable resin 9 by means of a coater 11, and is subsequently brought into pressure contact with a roll stamper 3 capable of undergoing elastic deformation, having on its surface preformat patterns. The part brought into pressure contact is irradiated with an ultraviolet lamp 13, so that preformat patterns for track grooves or address pits are transferred to a photo-cured resin layer.

Next, the numeral 35 denotes a coater for coating a recording layer material on the surface of the photo-cured resin layer 9′ on which the preformat patterns have been formed. The recording layer material can be coated using various printing methods. In the most simple method, as shown in Fig. 3, an ink obtained by dissolving in a suitable solvent a dye serving as a recording material is held in an ink reservoir denoted by 35′ and is fed through a single roll 35 to the surface of the photo-cured resin layer 9′ on which the preformat patterns have been formed.

Here, the recording layer material may preferably be coated from the underside of the substrate sheet. Namely, in principle, the recording layer material can be coated on the top surface side if a manufacture environment is kept perfectly clean, but it is impossible in reality to completely eliminate dust. Hence, the underside coating is very effective for preventing dust.

Next, the substrate sheet is passed through a tunnel dryer denoted by 36 to remove a solvent from the coating surface, and then a protective member 39 is formed. The protective member can be formed by various methods including (1) a

method in which a protective substrate or film is directly laminated on a recording layer, (2) a method in which a protective film is directly formed on the surface on which a recording layer has been formed, and (3) a method in which an air layer is provided above the surface on which a recording layer has been formed, and then a protective member is laminated thereon.

In the apparatus shown in Fig. 3, a protective sheet 39 is fed from a feed roll denoted by 37, and the protective member is laminated using a pressure roll 38. This process can be applied in the direct lamination as in the above method (1) or the lamination via an air layer as in the method (3). The protective substrate for use in the lamination in the method (3) is provided with a spacer at the outside of a recording area, and is previously processed to have concavities and convexities on a surface on the protective member side so that a given air layer can be retained at the time of lamination. Here is used a member separately obtained by processing a protective sheet by vacuum forming to have concavities and convexities on the surface, and wound up in a spiral form. Alternatively, in place of the process for providing the concavities and convexities, an adhesive with beads may be used, which is applied to the outer perimeter and/or inner perimeter of the outside of a recording area, and then a protective member is laminated thereon.

As the method in which a protective member is directly formed on a recording layer, there is, for example, a method in which a hot-melt adhesive is applied between the resin sheet and the protective member, and then a heat roll is passed through to make a lamination. They may be laminated by adhesion using an adhesive, by joining using a pressure-sensitive tape that also serves as a spacer, and, in addition thereto, by direct melt adhesion between the substrate and the protective member, using an ultrasonic welder or a hot press.

Next, the sheet thus provided with the protective member is separated into individual optical recording mediums by means of a cutting machine 44. The optical recording mediums thus separated (45) are delivered on a conveyor belt 48. A residual material 46 remaining after the cutting of optical recording mediums is wound up on a drum 47. The cutting is carried out by male-female type punching using an oil hydrauric press.

In the present invention, the substrate sheet is processed in the state of a continuous sheet, and hence the substrate sheet itself is moved until it reaches the step of cutting. Thus, it can be delivered by only a relatively simple roll transport system.

An automatical alignment or positioning mechanism may be optionally provided in the step of laminating the substrate sheet and the protective member or the step of punching the optical recording mediums. More specifically, since, in the instance where the air layer is provided using a backing material, a member is laminated at the outside of a recording area, the right-and-left positional movement or forward-and-backward feeding is controlled so that the position at which a preformat pattern is formed can be detected and the concavity and convexity of the backing material can be made to positionally correspond thereto.

The cutting step is required to be accurate particularly when optical disks are prepared, where the inner perimeter or outer perimeter of an optical disk is detected using reflected light of a laser spot or a position signal is detected with a CCD by reading a groove on a substrate or a marker specially provided thereon, according to which a punching press is moved.

In order to operate these positioning mechanisms in an adequate degree of freedom, the sheet is fed in a "loosened" state to a certain degree. The embodiment as shown in Fig. 3, in which the coating surface is provided on the underside of the sheet, is advantageous for preventing dust from adhering to the coating surface. However, used as a delivery roll should be a roll to hold the sheet at its side edges so that the roll may not be in touch with the coating surface correspondind to a recording surface.

Incidentally, the cutting of optical recording mediums, finally carried out among the steps shown in Fig. 3, can be carried out in a sufficiently short time. When the above marker for cutting is used, the substrate sheet may preferably be stopped so that the sheet can be cut in an improved accuracy. On the other hand, at the time when the substrate sheet resin is melt-extruded, the preformat patterns are formed and the recording layer is formed, the sheet should preferably be formed and delivered at a constant speed in order to prevent defects such as non-uniformity in the substrate sheet thickness, occurrence of strain in the substrate sheet, faulty transfer of a preformat pattern, and coating uneveness of a recording layer.

Then, a mechanism of loosening the substrate sheet may preferably be provided before the cutting step so that the steps through which the sheet is fed in a continuous state and the step in which the substrate sheet is stopped and cut can be successively carried out.

In Fig. 3, the numeral 42 denotes a loosening mechanism, in which the position of a roll is changed up and down by spring so that the steps through which the sheet is continuously delivered, ranging from the step of extruding the resin up to the step of laminating the protective member, and the cutting step in which the sheet is intermittently

fed can be continuously carried out in the state that both the steps are remain connected.

In addition to the steps shown in Fig. 3, a step of removing static charges and dust may be further optionally inserted so that the substrate sheet on which the preformat patterns have been formed can be prevented from attraction of dust due to static charge thereof. From the viewpoint of preventing the attraction of dust, it is also preferable to cover with a clean tunnel the desired sections ranging, for example, from the section at which the substrate sheet resin is melt-extruded, to the section corresponding to the step of forming the protective member.

Materials used for an optical recording layer may vary depending on whether the optical recording medium of the present invention is used for an ROM (read-only memory) in which the information previously formed on a substrate as preformatting information can only be read, or used for a memory in which additional information can be written. In the case of the former ROM, the recording layer may preferably have a higher reflectance, and, for example, a material comprising metal fine particles dispersed in a binder, or a heat-resistant dye or pigment may be used. In the latter case, it is preferable to use a material having both absorption and reflection to recording-reproducing light, and requiring a smaller energy necessary for causing changes in reflectance as a result of irradiation with energy beams. It is further preferable to use a material that may cause changes in ref lectance with difficulty, at the recorded areas (pits, etc.) and unrecorded areas.

Such an optical recording material includes, for example, anthraquinone derivatives (particularly those having an indanthrene skeleton), dioxazine compounds and derivatives thereof, triphenodithiazine compounds, phenanthrene derivatives, cyanine compounds, merocyanine compounds, pyrylium compounds, xanthene compounds, triphenylmethane compounds, chroconium coloring matters, azo coloring matters, chrocones, azines, indigoids, polymethine coloring matters, azulenes, squarilium derivatives, sulfur dyes, and metal dithiolate complexes.

These coloring matters may also be mixed with stabilizers. Such stabilizers include various types of metal chelate compounds, in particular, those comprising a multidentate ligand having a central metal such as Zn, Cu, Ni, Cr, Co, Mn, Pd and Zr, as exemplified by tetradentate ligands having N_4, N_2O_2, N_2S_2, S_4, O_2S_2, O_4, etc., or a combination of these, as well as various types of aromatic amines or diamines, nitrogen-containing aromatics, and onium salts thereof as exemplified by aminium salts, diimonium salts, pyridinium salts, imidazolinium salts, and quinolium salts. Pyrylium salts or the like which are salts of oxygen-containing aromatics may also be used. These stabilizers can be used in combination of plural ones.

The above various stabilizers are selected taking account of the compatibility with the above organic coloring matters and solvents used. The stabilizer may preferably be added in an amount of from 1 wt.% to 50 wt.% based on the organic coloring matter. In particular, when added in an amount of from 10 wt.% to 30 wt.%, the lowering of sensitivity can be less and the effect as the stabilizer can be high.

Solvents used in dissolving the above organic coloring matters and stabilizers may preferably include those which may not attack the resin sheet. It is possible to use diacetone alcohol, cellosolve, and 1-methoxy-2-propanol, and also mixed solvents composed of any of the above solvents to which a solvent of a halogen type has been added in a small amount.

The sheet-like optical recording medium prepared in this way is then cut or punched out to be formed into individual optical disks or optical cards, depending on the preformat signals to be recorded.

In practical use, steps of labeling, lot number printing, casing, and so forth may be optionally added in the course of these steps or after completion of the steps. An inspection step, and a feed back based on the inspection may also be optionally provided. For example, as an optical inspection, a means for inspecting double refraction, reflectance or light-transmittance of a medium or a coating film, or defects such as scratches and inclusion of dust, a means for measurement for judging the quality of sheet thickness or grooves formed, and a means for evaluating the performance as a disk or card, can be provided in the course of or after the steps.

As having been described above, according to the present invention, which employs as the roll stamper a roll stamper capable of undergoing elastic deformation, a substrate sheet for optical recording mediums, that can prevent bubbles from being included in a photo-curable resin layer and is improved in the follow-up action between a roll stamper and a substrate sheet so that the rate of errors can be decreased, can be produced continuously and in a high productivity.

EXAMPLES

The present invention will be described below in greater detail by giving Examples.

Example 1

A photoresist (trade name: AZ-1300; a product of Hoechst Japan Ltd.) film was formed on a glass master to have a film thickness of 1,000 Å, followed by exposure using a laser beam cutting device and then developing to form a preformat pattern comprised of concavities and convexities. Next, on the pattern thus formed, an Ni thin film was formed by sputtering so that its surface was made conductive, and thereafter an Ni deposit of 0.1 mm in thickness was formed by electroforming. Next, the Ni deposit was peeled from the glass master. Flat sheet stampers made of Ni, used for 3.5 inch optical disks were thus obtained, each having a preformat pattern in a spiral form of 0.6 µm in groove width, 1.6 µm in pitch and 900 Å in groove depth.

On the other hand, on the periphery of a stainless steel core of 350 mm in outer diameter and 15 mm in width, whose surface had been mirror-finished, an elastomer layer 5 made of chloroprene rubber was formed with a thickness of 50 mm by wrap-and-steam molding so as to give an outer diameter of 400 mm. A rubber roll was thus prepared.

Next, using an epoxy adhesive (trade name: EP-170; a product of Cemedine Co., Ltd.), 12 pieces of the flat sheet stampers made of Ni, thus obtained, were stuck fast in a row on the periphery of the above rubber roll. A roll stamper was thus prepared.

A polycarbonate substrate sheet of 1.2 mm in thickness and 130 mm in width was used as the substrate sheet 1. An ultraviolet-curable resin of an epoxy acrylate type (MRA-5000, a product of Mitsubishi Rayon Co., Ltd.) was applied to the pattern surface of the roll stamper to give a thickness of 25 µm. The substrate sheet was fed at a speed of 2.5 m/min. The substrate sheet was brought into close contact with the roll stamper by means of the nip roll. Thereafter, the ultraviolet-curable resin layer thereby spread out was irradiated with ultraviolet rays (a 4 kW high-pressure mercury lamp, 300 mW/cm^2) for 15 seconds over the whole surface of the substrate sheet, and the ultraviolet-curable resin layer was thus cured and made to be in close contact with the substrate sheet.

Next, the substrate sheet and the ultraviolet-cured resin layer formed thereon were peeled from the roll stamper. Thus, a substrate sheet having a track groove pattern of 0.6 µm in groove width, 1.6 µm in pitch and 900 Å in groove depth was obtained. No defective bubbles were visually seen on the substrates thus obtained. A mask was covered on this substrate sheet and then disk substrates were cut therefrom using a CO_2 laser cutter. The rate of errors of the substrates was measured to reveal that an average value of 10 pieces was 5 x 10^{-6}.

Comparative Example 1

Disk substrates with preformat patterns were obtained according to the same procedure as in Example 1, except that a roll stamper comprising a stainless steel roll of 400 mm in outer diameter on the surface of which flat sheet stampers made of Ni were stuck with an epoxy adhesive. Some bubbles were seen in the substrates thus obtained. The rate of errors thereof was measured to reveal that an average value of 10 pieces was 6 x 10^{-5}.

Example 2

A photoresist (trade name: AZ-1300; a product of Hoechst Japan Ltd.) film was formed on a glass master to have a film thickness of 3,000 Å, followed by exposure using a laser beam cutting device and then developing to form a preformat pattern corresponding with track grooves for an optical card. Next, on the pattern thus formed, a silicone resin (trade name: KE10; a product of Shin-Etsu Silicone Co., Ltd.) was coated in a thickness of 5 mm. The resulting coating was cured at 60°C for 3 hours, and then peeled from the glass master. Stampers made of silicone resin, used for optical cards were thus obtained, each having a preformat pattern corresponding with tracking grooves for an optical card, which are in a stripe form of 3 µm in groove width, 12 µm in pitch and 3,000 Å in groove depth.

Using a silicone resin adhesive (trade name: KE41; a product of Shin-Etsu Silicone Co., Ltd.), 10 pieces of the stampers thus obtained were stuck fast in a row on the surface of a core roll made of stainless steel, of 200 mm in outer diameter and 130 mm in width. A roll stamper was thus prepared.

Using this roll stamper, an apparatus as shown in Fig. 2 for producing a substrate sheet for optical cards was made up.

A polycarbonate substrate sheet of 0.4 mm in thickness and 120 mm in width was used as the substrate sheet. The substrate sheet was fed at a speed of 3 m/min, followed by the same procedure as in Example 1. A substrate sheet for optical cards having stripe-like tracking grooves of 3 µm in groove width, 12 µm in pitch and 3,000 Å in groove depth was thus obtained. No defective bubbles were seen on the substrates thus obtained. The rate of errors of the card substrates was measured to reveal that an average value of 10 pieces was 7 x 10^{-6}.

Example 3

A roll stamper was prepared in the same manner as in Example 2, except that a pattern corresponding with stripe-like tracking grooves for an optical card, of 2.5 µm in groove width, 12 µm in pitch and 3,000 Å in groove depth was formed-as the preformat pattern formed on the roll stamper 3. Using this roll stamper, an apparatus as shown in Fig. 3 for producing optical cards was made up.

Using pellets of polycarbonate having an average molecular weight of 25,000, a substrate sheet was formed under conditions of an extrusion width of 200 mm, a roll gap of 0.4 mm and an extrusion speed of 3 m/min. Subsequently, this substrate sheet 1 was coated with an ultraviolet-curable resin 9 in a coating thickness of 30 µm, using a roll coater 11. Polyurethane acrylate (trade name: UVX-SS120; a product of Three Bond Co., Ltd.) was used as the ultraviolet-curable resin.

The resin stampers stuck on the roll stamper 3 were 90 mm x 60 mm in dimensions for each stamper, which are large enough to cover an optical card (85 mm x 54 mm), and a pattern was formed in an area of 85 mm x 30 mm.

Next, the roll stamper 3 was brought into close contact with an ultraviolet-curable resin layer 9′, and irradiated with light at an intensity of 100 W/cm using an ultraviolet lamp 13 at a distance of 50 mm. Preformat patterns were thus transferred and fixed to an ultraviolet-cured resin layer.

Next, a recording layer was formed by coating using a roll coater 35 so that it was formed over the whole surface of the substrate sheet on which the tracking grooves were formed. A solution obtained by dissolving a polymethine dye (trade name IR-820; a product of Nippon Kayaku Co., Ltd.) in diacetone alcohol in a concentration of 2 wt.% was used as a recording layer coating solution 35′.

The recording layer was dried in the following manner: Dried air passed through an air filter of 0.2 µm thick, heated to 30 °C, was flowed at a speed of from 1 m/min to 5 m/min so that a laminar flow was produced in a tunnel of 3 m, from the direction opposite to the flow of the sheet.

Next, as a protective member 39, a polycarbonate sheet of 0.25 mm thick was superposed on the substrate sheet on which the recording layer was formed, interposing a film-like hot-melt adhesive between them, which were then laminated through a heated press roll 38 to give a total thickness of 0.7 mm. The resulting sheet was punched using a press cutting machine 44 along cut markers previously formed (which were formed at the same time with the formation of preformat patterns).

It was possible to cut the sheet in sufficiently short time. Since, however, the sheet was not continuously fed, the mechanism of "loosening" the sheet was provided between the formation of the protective member and the cutting so that the sheet can be continuously fed.

The rate of errors of the optical cards thus prepared was measured to reveal that an average value of 10 pieces was 6 x 10^{-6}.

Claims

1. An apparatus for producing a substrate sheet for optical recording mediums, comprising;
a means for forming an photo-curable resin layer on at least one of a substrate sheet and a roll stamper having thereon a pattern corresponding with preformatting information;
a means for bringing the substrate sheet into close contact with the roll stamper, interposing said photo-curable resin layer between them; and
a means for curing said photo-curable resin layer;
said roll stamper being so formed as to undergo elastic deformation.

2. An apparatus for producing a substrate sheet for optical recording mediums according to Claim 1, wherein said roll stamper comprises a core made of a metal, having an elastomer layer on its periphery, and a flat-sheet stamper fixed on said elastomer layer.

3. An apparatus for producing a substrate sheet for optical recording mediums according to Claim 2, wherein said elastomer layer has a thickness of from 0.1 mm to 100 mm.

4. An apparatus for producing a substrate sheet for optical recording mediums according to Claim 3, wherein said elastomer layer has a thickness of from 0.5 mm to 50 mm.

5. An apparatus for producing a substrate sheet for optical recording mediums according to Claim 1, wherein said elastomer layer has a hardness of from 5 to 100 according to JIS-A hardness.

6. An apparatus for producing a substrate sheet for optical recording mediums according to Claim 1, wherein said elastomer layer has a hardness of from 10 to 80 according to JIS-A hardness.

7. An apparatus for producing a substrate sheet for optical recording mediums according to Claim 2, wherein said elastomer layer comprises at least one elastomer selected from the group consisting of a polyurethane, a natural rubber, an isoprene rubber, a chloroprene rubber and a silicone rubber.

8. An apparatus for producing a substrate sheet for optical recording mediums according to Claim 1, wherein said roll stamper comprises a core roll made of a metal, and a stamper comprising an elastomer, fixed on its periphery.

9. An apparatus for producing a substrate sheet for optical recording mediums according to Claim 8, wherein said stamper has a thickness of from 0.1

mm to 50 mm..

10. An apparatus for producing a substrate sheet for optical recording mediums according to Claim 9, wherein said stamper has a thickness of from 0.5 mm to 10 mm..

11. An apparatus for producing a substrate sheet for optical recording mediums according to Claim 8, wherein said stamper has a hardness of from 10 to 100 according to JIS-A hardness.

12. An apparatus for producing a substrate sheet for optical recording mediums according to Claim 11, wherein said stamper has a hardness of from 30 to 90 according to JIS-A hardness.

13. An apparatus for producing a substrate sheet for optical recording mediums according to Claim 8, wherein said stamper comprises at least one elastomer selected from the group consisting of a silicone resin and a fluorine resin.

14. An apparatus for producing a substrate sheet for optical recording mediums according to Claim 1, wherein said roll stamper has on its surface a preformat pattern corresponding with preformatting information.

15. A process for producing a substrate sheet for optical recording mediums, comprising the steps of;

forming an photo-curable resin layer on at least one of a substrate sheet and a roll stamper having thereon a pattern corresponding with preformatting information;

bringing the substrate sheet into close contact with the roll stamper, interposing said photo-curable resin layer between them;

irradiating said photo-curable resin layer with light to transfer said pattern to the photo-curable resin layer, and at the same time fixing said photo-curable resin layer to the substrate sheet; and

peeling from the roll stamper the substrate sheet on which a photo-cured resin layer has been fixed;

said roll stamper being so formed as to undergo elastic deformation.

16. A process for producing a substrate sheet for optical recording mediums according to Claim 15, wherein photo-curable resin layers are formed on both said substrate sheet and said roll stamper.

17. A process for producing a substrate sheet for optical recording mediums according to Claim 15, wherein a roll stamper comprising a core roll made of a metal, having an elastomer layer on its periphery, and a flat-sheet stamper fixed on said elastomer layer, is used as said roll stamper.

18. A process for producing a substrate sheet for optical recording mediums according to Claim 15, wherein a roll stamper comprising a core roll made of a metal, and a stamper comprising an elastomer, fixed on its periphery, is used as said roll stamper.

19. An apparatus for producing an optical recording medium, comprising continuously;

a means for melting a resin and extruding the molten resin to form a resin sheet;

a means for forming a photo-curable resin layer on at least one of a substrate sheet and a roll stamper having thereon a pattern corresponding with preformatting information;

a means for bringing the substrate sheet into close contact with the roll stamper, interposing said photo-curable resin layer between them;

a means for curing said photo-curable resin layer;

a means for peeling from the roll stamper the substrate sheet on which a photo-cured resin layer has been fixed;

a means for forming a recording layer on the surface of the substrate sheet on which said pattern has been formed;

a means for forming a protective member on the surface on which said recording layer has been formed; and

a means for individually cutting said substrate sheet having said recording layer and protective member;

said roll stamper being so formed as to undergo elastic deformation.

20. A process for producing an optical recording medium, comprising continuously the steps of;

melting a resin and extruding the molten resin to form a resin sheet;

forming a photo-curable resin layer on at least one of a substrate sheet and a roll stamper having thereon a pattern corresponding with preformatting information;

bringing the substrate sheet into close contact with the roll stamper, interposing said photo-curable resin layer between them;

curing said photo-curable resin layer to fix the layer to said substrate sheet;

peeling from the roll stamper the substrate sheet on which a photo-cured resin layer has been fixed;

forming a recording layer on the surface of the substrate sheet on which said pattern has been formed;

forming a protective member on the surface on which said recording layer has been formed; and

individually cutting said substrate sheet having said recording layer and protective member;

said roll stamper being so formed as to undergo elastic deformation.

21. Use in the production of a substrate sheet for optical recording media of a deformable stamper to reduce defects in the resulting recording media.

22. A stamper for use in the production of optical recording media characterised in that the stamper is deformable.

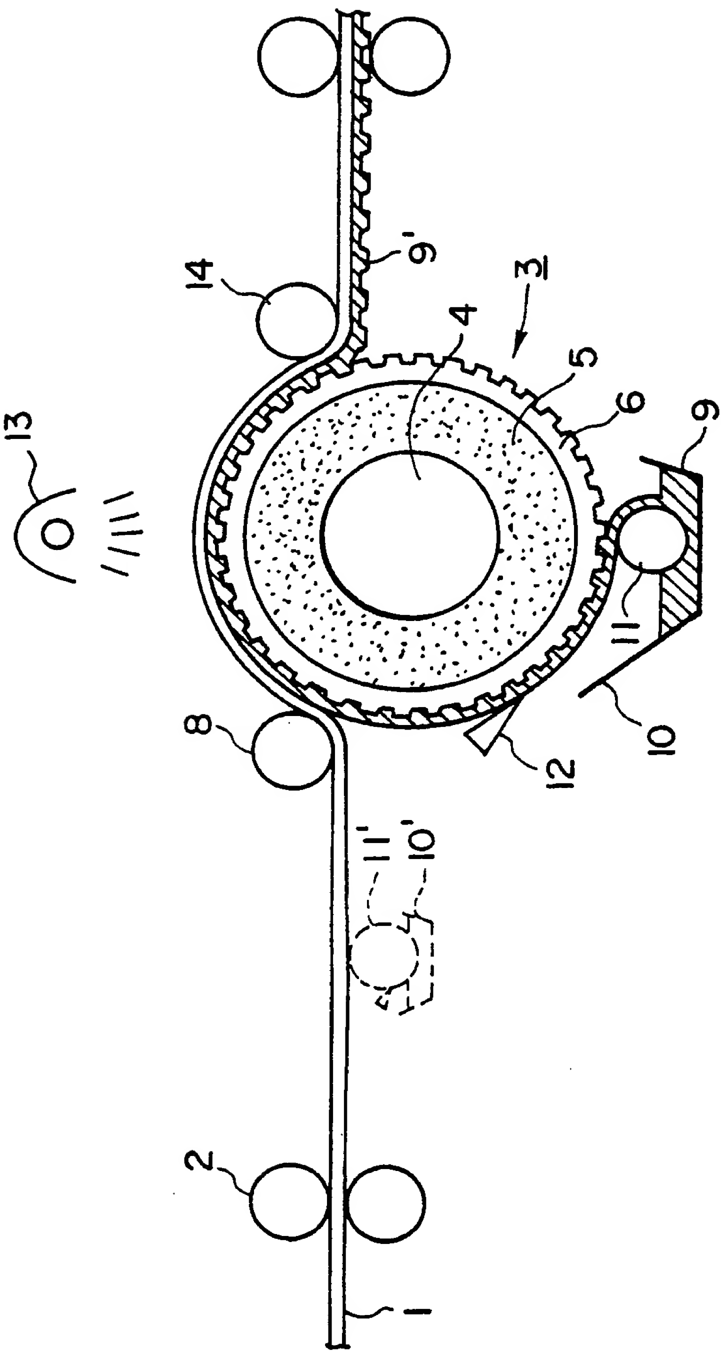


FIG. 1

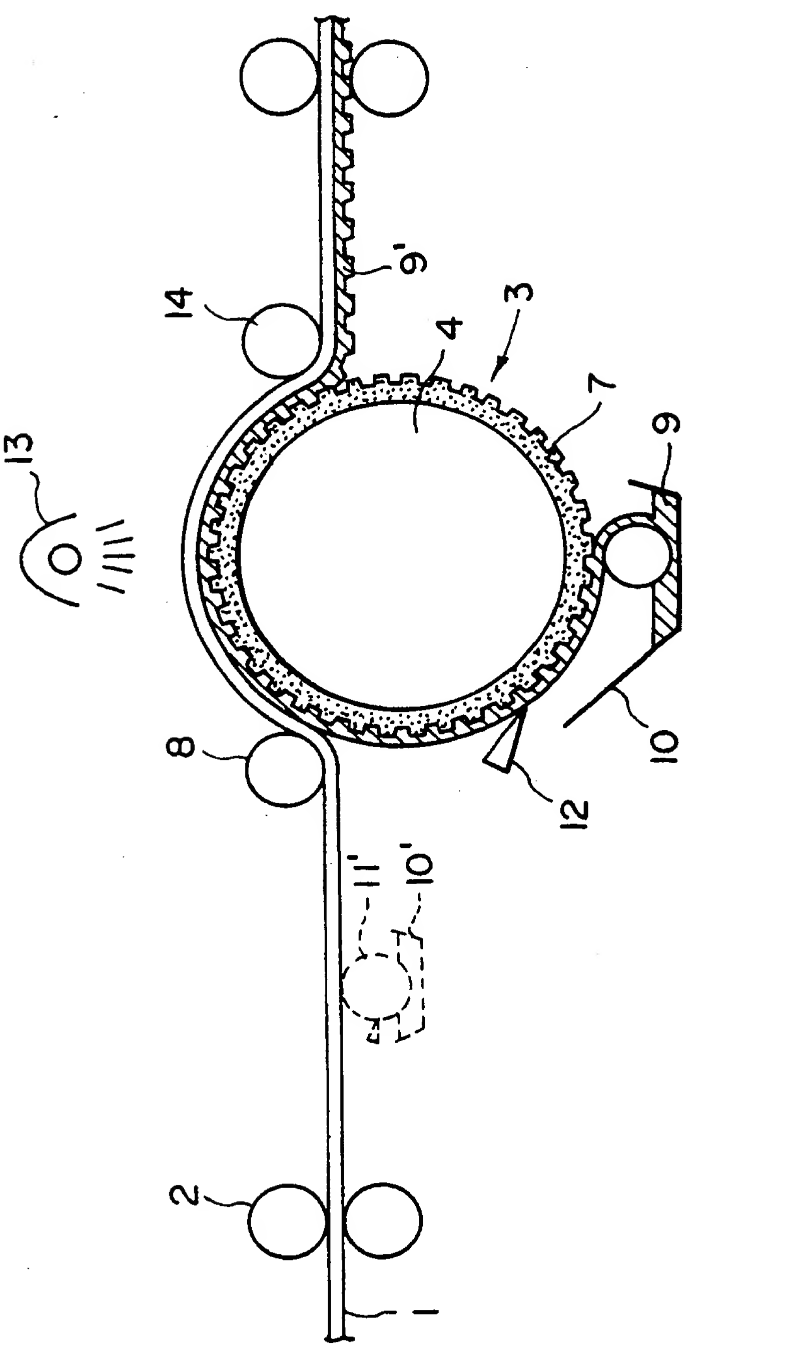


FIG. 2

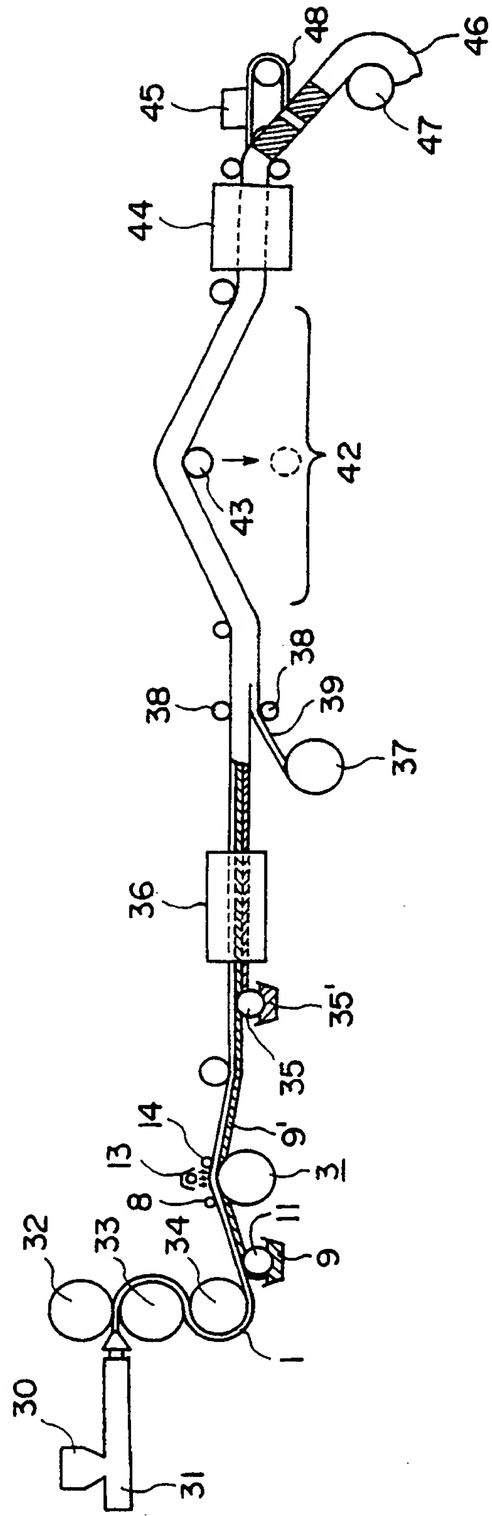


FIG. 3

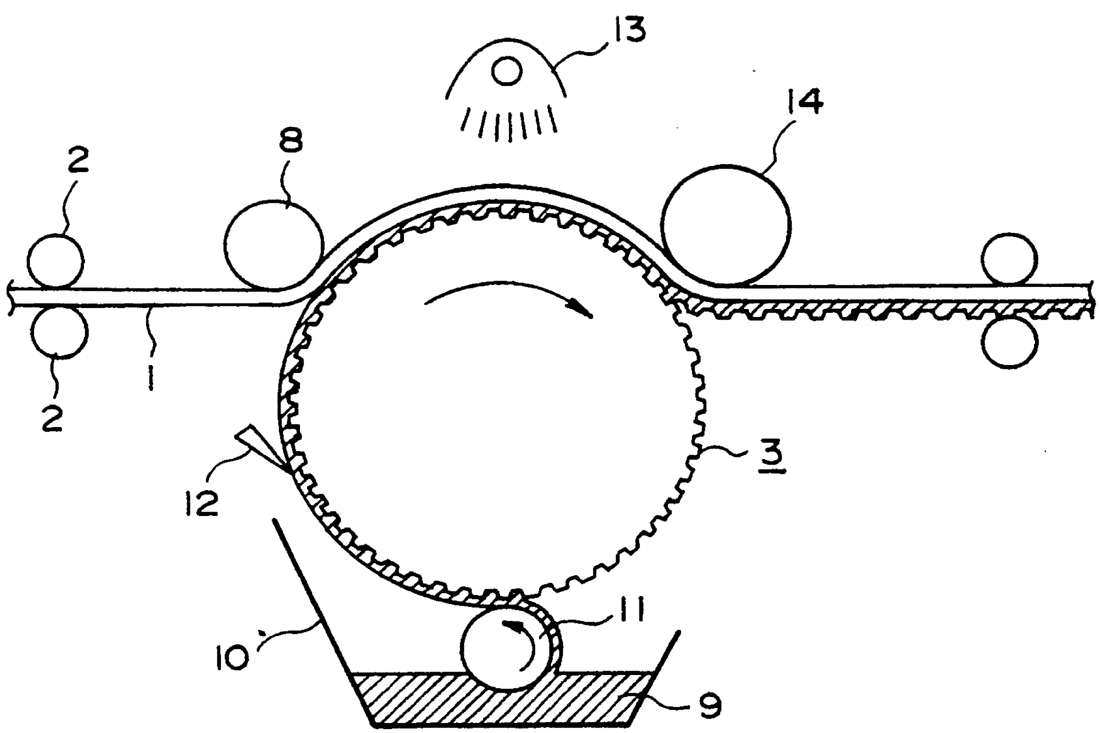


FIG. 4